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(54) **CAPTURING AND ANALYZING USER ACTIVITY DURING A MULTI-USER VIDEO CHAT SESSION**

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H04L 29/06	(2006.01)
H04L 29/08	(2006.01)

(52) **U.S. Cl.**
CPC *H04L 65/403* (2013.01); *H04L 65/601* (2013.01); *H04L 67/22* (2013.01)

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See application file for complete search history.

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(57) **ABSTRACT**
A system for facilitating a multi-user video chat session, wherein the system comprises multiple electronic client devices and a server. The server receives, from each client device, an information unit representing user activity at the client device. The server selects one or more information units based on measurements of user activity in the information units received. The server generates a combined video stream including said selected one or more information units, wherein the combined video stream is sent to at least one client device.

27 Claims, 11 Drawing Sheets
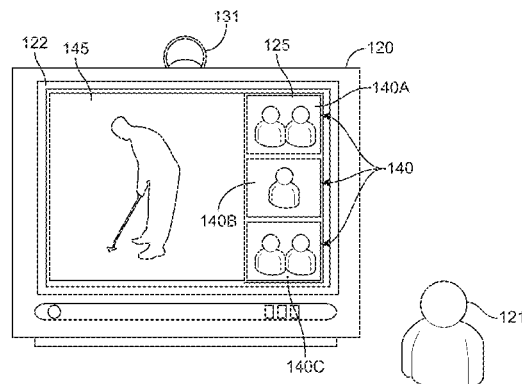
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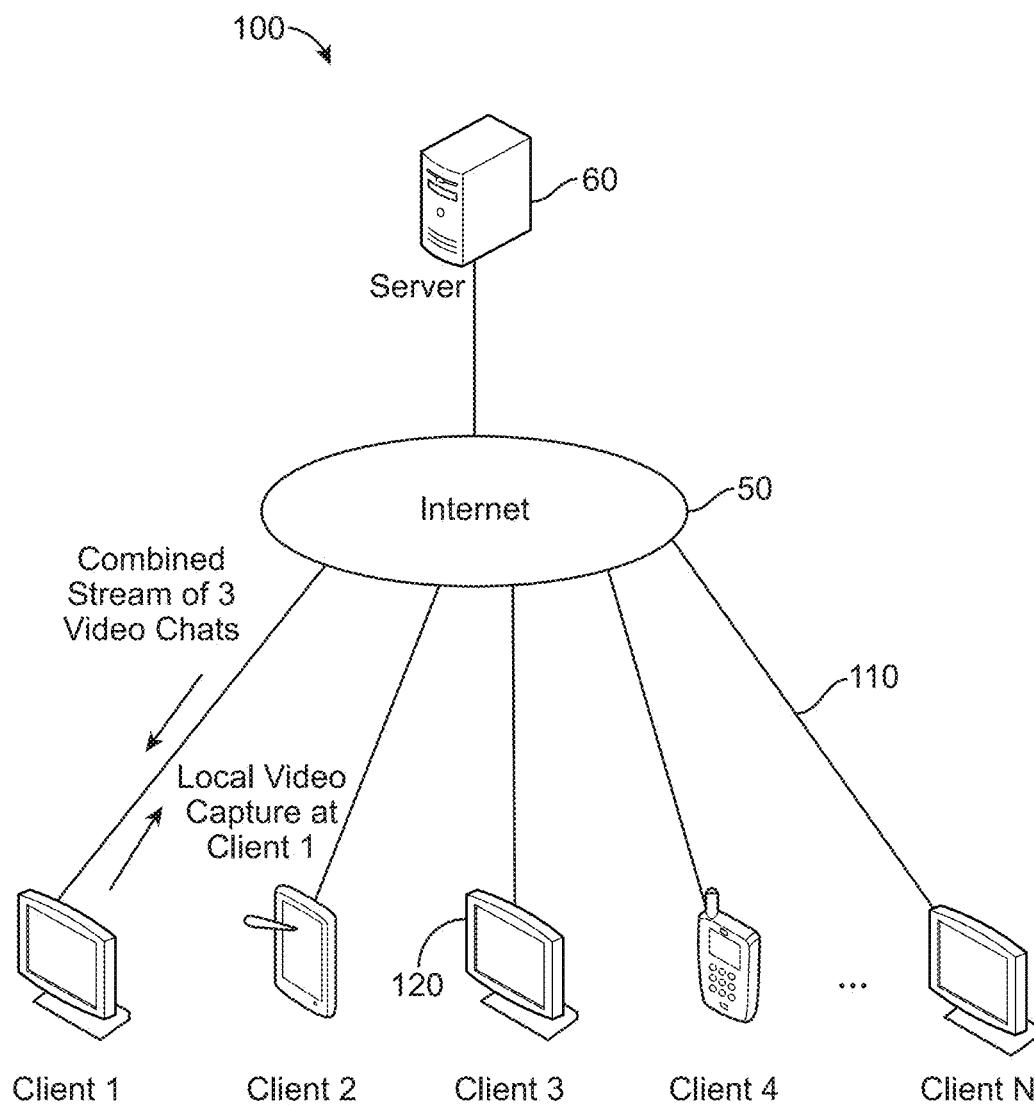
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100

60

Server

Internet   50

Combined
Stream of 3
Video Chats

110

Local Video
Capture at
Client 1

120

Client 1   Client 2   Client 3   Client 4   ...   Client N

FIG. 1

120

122   200

Display   User Interest
Measurement

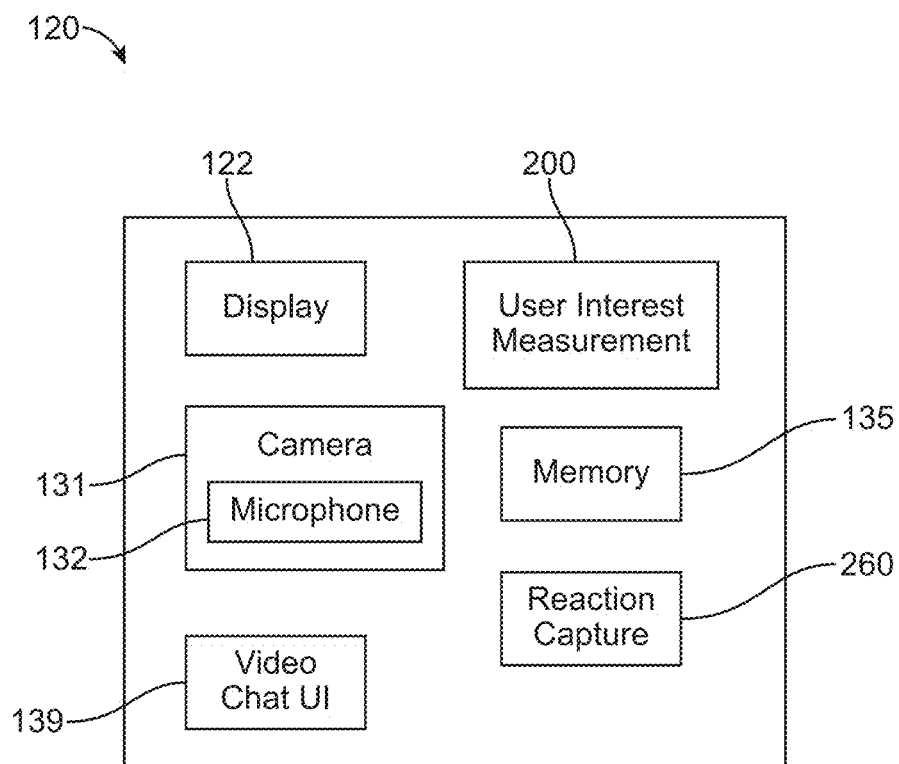Camera
131

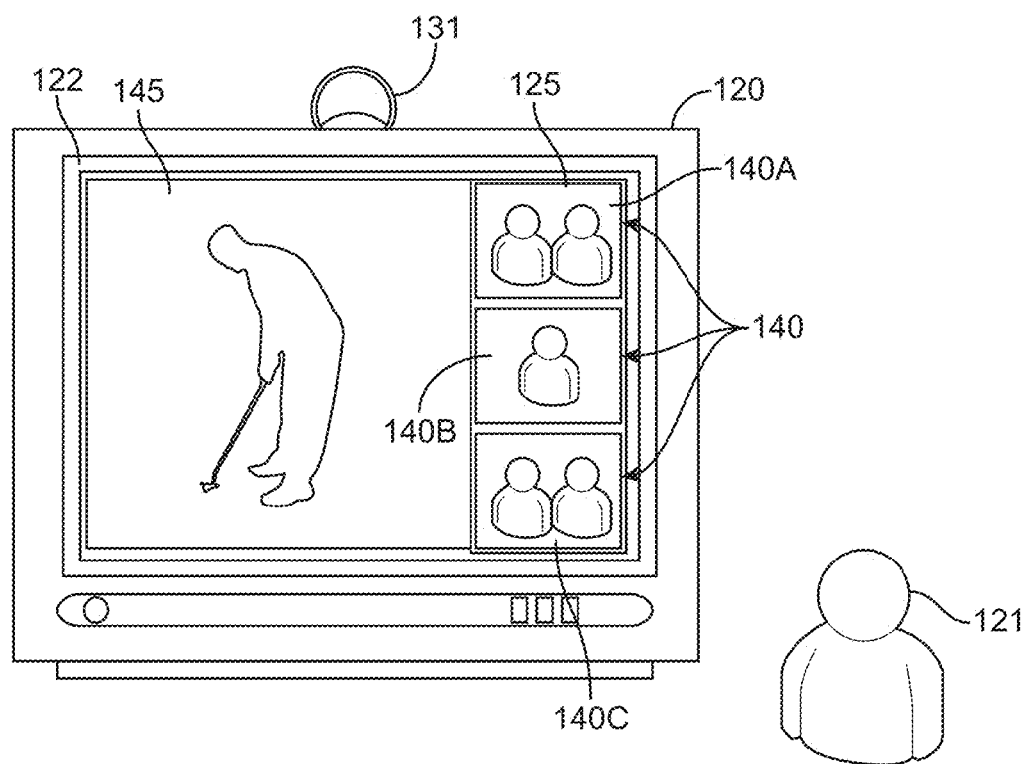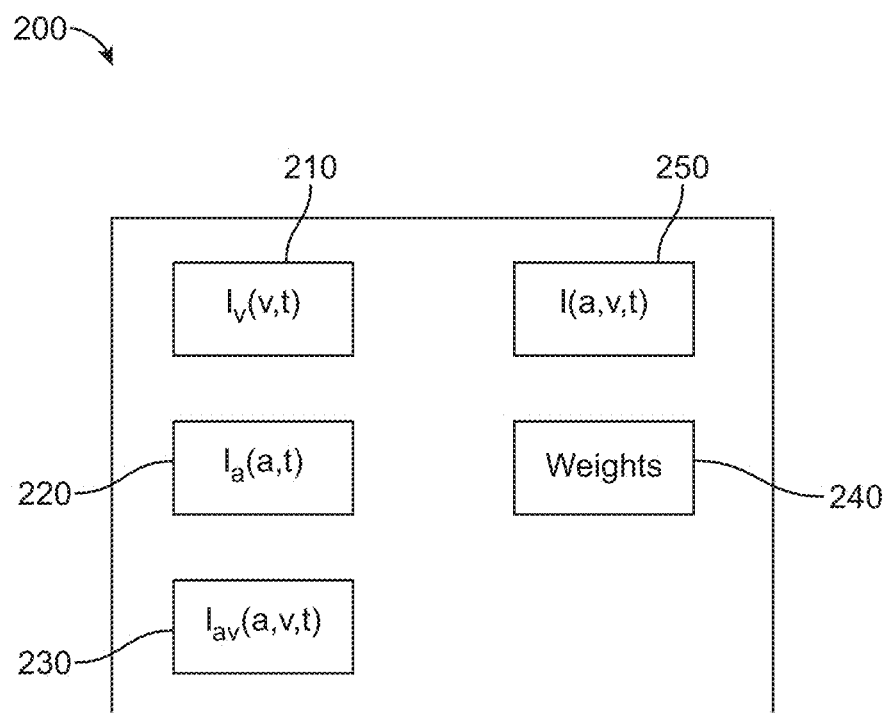Microphone   Memory   135
132

Reaction   260
Capture

Video
Chat UI
139

FIG. 2A

FIG. 2B

FIG. 3

FIG. 4

FIG. 5
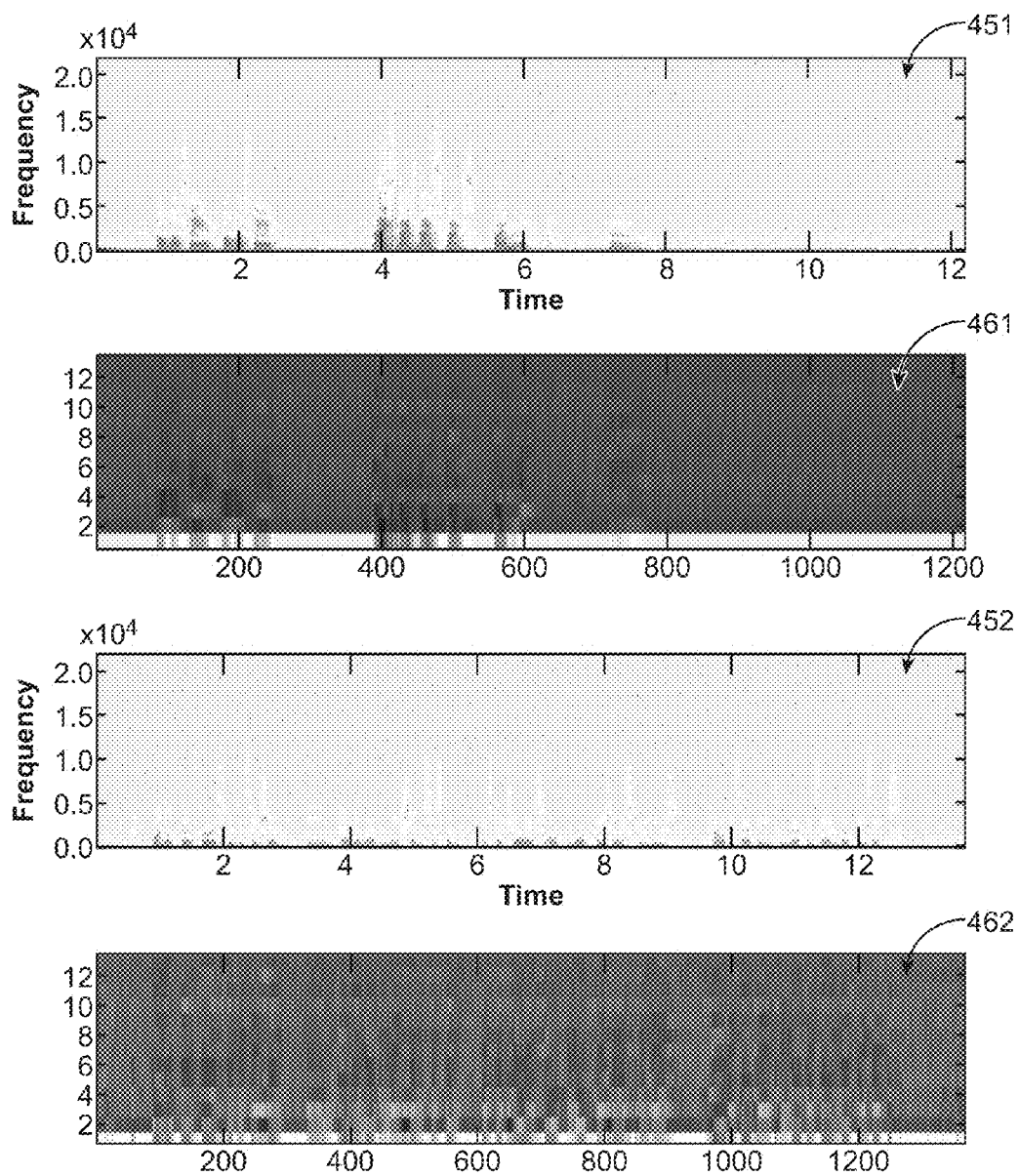
FIG. 6

280

Reaction Capture file starts

The value of User Interest Metric exceeds a threshold

User becomes Active

$T_3 - T_b$ T_1 T_3

The value of User Interest Metric drops below a threshold

Reaction Capture ends

User becomes Inactive

T_2 T_4 $T_4 + T_c$

On-going Video Recording

On-going User Interest Metric Calculation

t

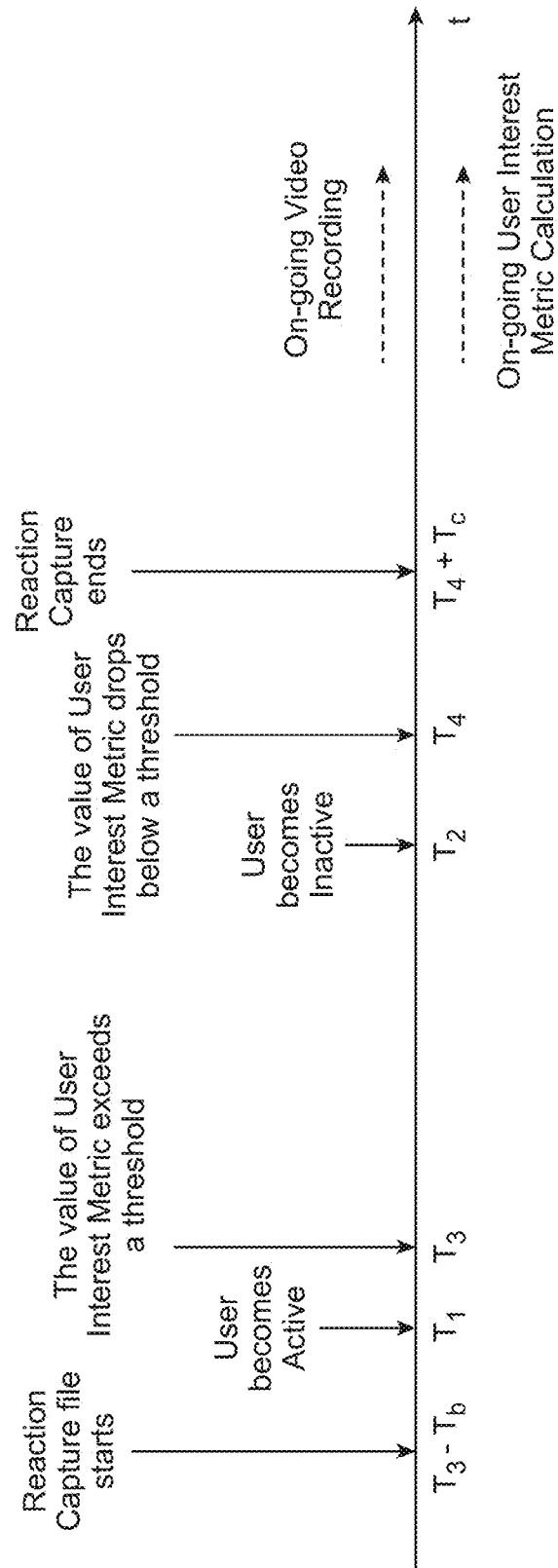FIG. 7

60

Video
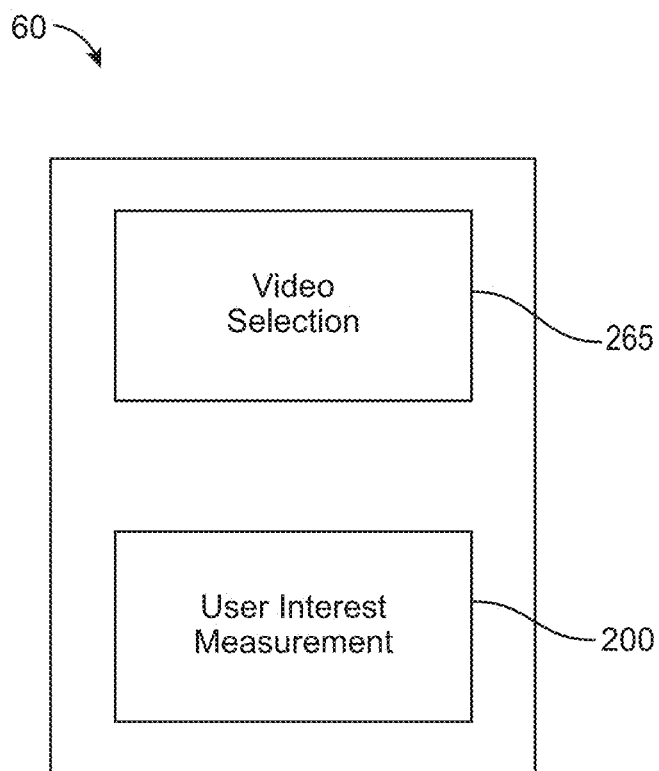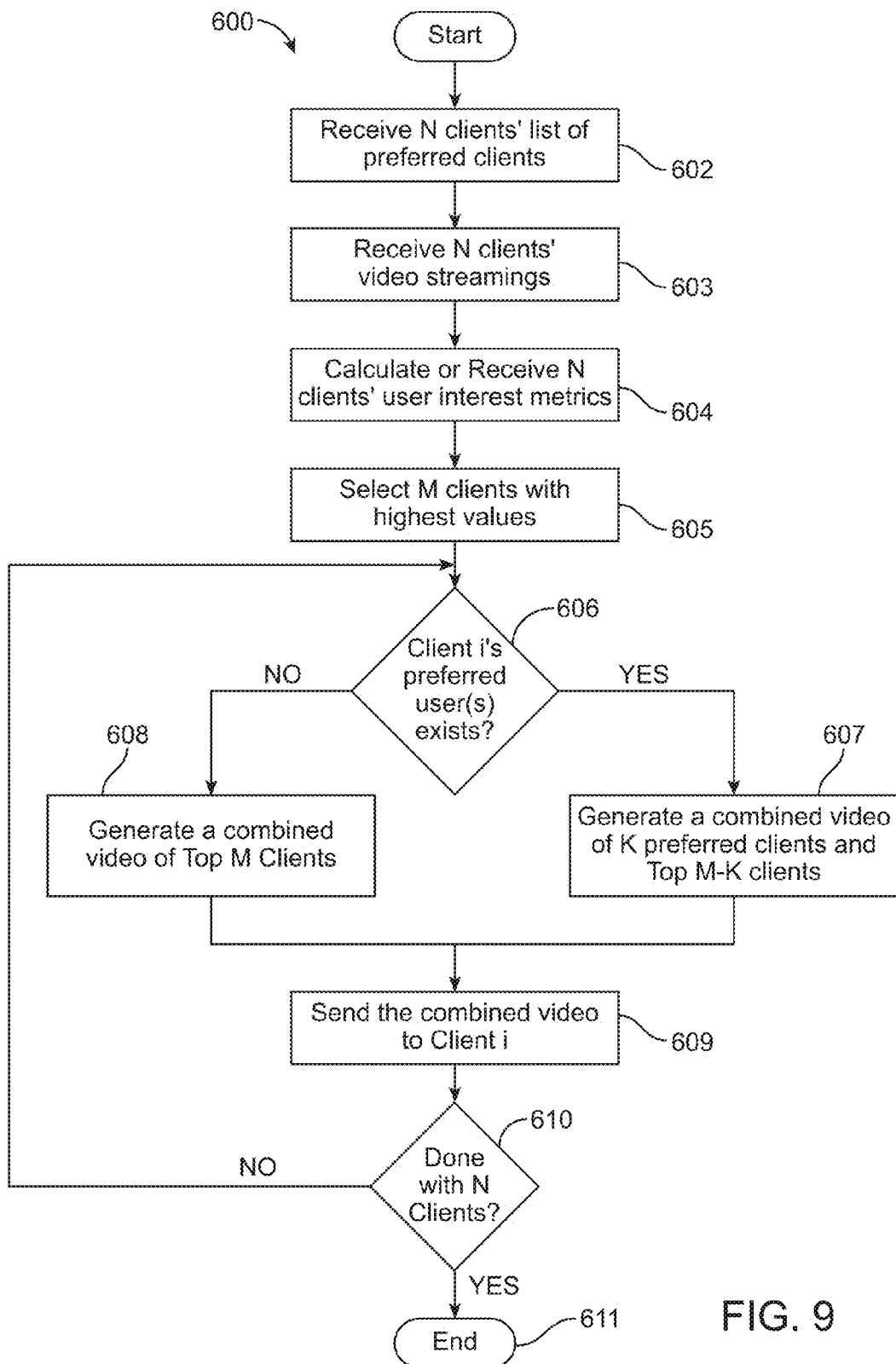Selection —265

User Interest
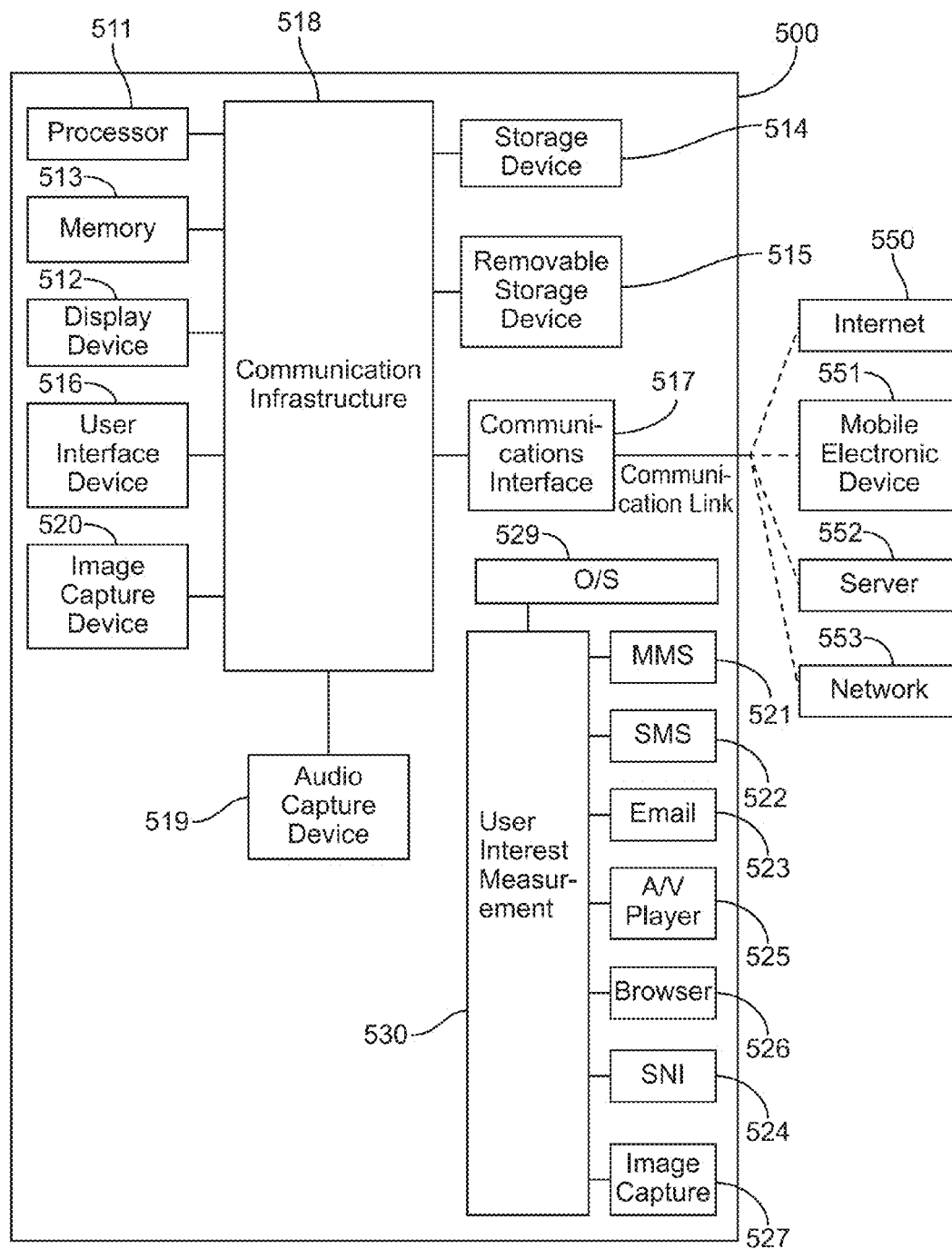Measurement —200

FIG. 8

FIG. 9

FIG. 10

CAPTURING AND ANALYZING USER ACTIVITY DURING A MULTI-USER VIDEO CHAT SESSION

TECHNICAL FIELD

One or more embodiments relate generally to multi-user video chatting, and in particular to capturing and analyzing user activity during a multi-user video chat session.

BACKGROUND

A multi-user video chat system enables video chatting between multiple users. A video chat system enables a user participating in a video chat session to transmit live or semi-live video of the user to other users involved in the video chat session. Video chats are typically conducted via an electronic device such as a computer, a laptop, a tablet or a phone, and may involve point-to-point (i.e., one-to-one) interaction or multipoint (i.e., one-to-many) interaction.

SUMMARY

One embodiment provides a system for facilitating a multi-user video chat session, wherein the system comprises multiple electronic client devices and a server. The server receives, from each client device, an information unit representing user activity at the client device. Each information unit received from each client device comprises a video stream capturing user activity at the client device. The server selects one or more information units based on measurements of user activity in the information units received. The server generates a combined video stream including the selected one or more information units, wherein the combined video stream is sent to at least one client device.

One embodiment provides a method for facilitating a multi-user video chat session. The method comprises receiving information units from multiple client devices, wherein each information unit represents user activity at a client device. Each information unit received from each client device comprises a video stream capturing user activity at the client device. One or more information units are selected based on measurements of user activity in the information units received. A combined video stream including the selected one or more information units is generated, wherein the combined video stream is sent to at least one client device.

One embodiment provides a non-transitory computer-readable medium having instructions which when executed on a computer perform a method for facilitating a multi-user video chat session. The method comprises receiving information units from multiple client devices, wherein each information unit represents user activity at a client device. Each information unit received from each client device comprises a video stream capturing user activity at the client device. One or more information units are selected based on measurements of user activity in the information units received. A combined video stream including the selected one or more information units is generated, wherein the combined video stream is sent to at least one client device.

One embodiment provides an electronic device for facilitating a multi-user video chat session. The electronic device comprises a display configured to display a piece of content, a camera configured to capture a video stream of user activity during playback of the piece of content, and a graphical user interface (GUI) application module. The GUI module is configured to receive a combined video stream

including at least one video stream of user activity at a different electronic device, and generate a GUI comprising at least one video chat window. Each video chat window includes a video stream of user activity at a different electronic device. The display is further configured to simultaneously display the piece of content and the GUI generated.

One embodiment provides a graphical user interface (GUI) displayed on a display of an electronic client device. The GUI comprises a first window for displaying a piece of content, and a video chat interface for facilitating a multi-user video chat session during playback of the piece of content.

These and other aspects and advantages of one or more embodiments will become apparent from the following detailed description, which, when taken in conjunction with the drawings, illustrate by way of example the principles of one or more embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the nature and advantages of one or more embodiments, as well as a preferred mode of use, reference should be made to the following detailed description read in conjunction with the accompanying drawings, in which:

FIG. 1 illustrates an example architecture for a system for capturing and analyzing user activity, in accordance with an embodiment.

FIG. 2A illustrates an example block diagram of a client device, in accordance with an embodiment.

FIG. 2B illustrates an example user interface displayed on a client device participating in a group video chat, in accordance with an embodiment.

FIG. 3 illustrates a block diagram of a user interest measurement application module, in accordance with an embodiment.

FIG. 4 illustrates motion detection processing of a video frame, in accordance with an embodiment.

FIG. 5 illustrates graphs corresponding to the metrics calculated by the video unit, in accordance with an embodiment.

FIG. 6 illustrates example audio spectrums, in accordance with an embodiment.

FIG. 7 is a timeline illustrating the capture of a user reaction, in accordance with an embodiment.

FIG. 8 illustrates a block diagram of a server unit, in accordance with an embodiment.

FIG. 9 illustrates an example flow chart for selecting video streams to include in a combined video stream, in accordance with an embodiment.

FIG. 10 is a high-level block diagram showing an information processing system comprising a computing system implementing an embodiment.

DETAILED DESCRIPTION

The following description is made for the purpose of illustrating the general principles of one or more embodiments and is not meant to limit the inventive concepts claimed herein. Further, particular features described herein can be used in combination with other described features in each of the various possible combinations and permutations. Unless otherwise specifically defined herein, all terms are to be given their broadest possible interpretation including

meanings implied from the specification as well as meanings understood by those skilled in the art and/or as defined in dictionaries, treatises, etc.

One or more embodiments relate generally to multi-user video chatting, and in particular to capturing and analyzing user activity during a multi-user video chat session. One embodiment provides a system for facilitating a multi-user video chat session, wherein the system comprises multiple electronic client devices and a server. The server receives, from each client device, an information unit representing user activity at the client device. Each information unit received from each client device comprises a video stream capturing user activity at the client device. The server selects one or more information units based on measurements of user activity in the information units received. The server generates a combined video stream including the selected one or more information units, wherein the combined video stream is sent to at least one client device.

One embodiment provides a method for facilitating a multi-user video chat session. The method comprises receiving information units from multiple client devices, wherein each information unit represents user activity at a client device. Each information unit received from each client device comprises a video stream capturing user activity at the client device. One or more information units are selected based on measurements of user activity in the information units received. A combined video stream including the selected one or more information units is generated, wherein the combined video stream is sent to at least one client device.

One embodiment provides a non-transitory computer-readable medium having instructions which when executed on a computer perform a method for facilitating a multi-user video chat session. The method comprises receiving information units from multiple client devices, wherein each information unit represents user activity at a client device. Each information unit received from each client device comprises a video stream capturing user activity at the client device. One or more information units are selected based on measurements of user activity in the information units received. A combined video stream including the selected one or more information units is generated, wherein the combined video stream is sent to at least one client device.

In one embodiment, each client device receives the same combined video stream from the server. In another embodiment, the server is further configured to receive, from each client device, user preferences for the client device, wherein the server generates a combined video stream for the client device based on the user preferences for the client device.

In one embodiment, the server is further configured to for each video stream received, measure user activity captured in the video stream. In another embodiment, the server is further configured to receive, from each client device, a measurement of user activity captured at the client device.

In one embodiment, the selected one or more information units includes a video stream with the highest measurement of user activity.

One embodiment provides an electronic device for facilitating a multi-user video chat session. The electronic device comprises a display configured to display a piece of content, a camera configured to capture a video stream of user activity during playback of the piece of content, and a graphical user interface (GUI) application module. The GUI module is configured to receive a combined video stream including at least one video stream of user activity at a different electronic device, and generate a GUI comprising at least one video chat window. Each video chat window

includes a video stream of user activity at a different electronic device. The display is further configured to simultaneously display the piece of content and the GUI generated.

The electronic device receives the combined video stream from a server. The electronic device sends the video stream of user activity captured by the camera to the server.

The electronic device further comprises a user interest measurement application module for measuring user interest of the piece of content based on a measurement of user activity, wherein the electronic device sends data relating to the measured user interest to the server.

The electronic device further comprises a reaction capture application module for detecting and recording a user reaction during playback of the piece of content. The recorded user reaction is sent to at least one of: the server, and a social networking site.

In one embodiment, the electronic device sends user preferences to the server, and the combined video stream received from the server is based on the user preferences.

One embodiment provides a graphical user interface (GUI) displayed on a display of an electronic client device. The GUI comprises a first window for displaying a piece of content, and a video chat interface for facilitating a multi-user video chat session during playback of the piece of content.

The video chat interface includes at least one video chat window. Each video chat window includes a video stream of user activity captured at a different client device.

In one embodiment, the number of video chat windows displayed is based on user preferences. In one embodiment, the number of video chat windows displayed is based on capabilities of the client device.

These and other aspects and advantages of one or more embodiments will become apparent from the following detailed description, which, when taken in conjunction with the drawings, illustrate by way of example the principles of one or more embodiments.

FIG. 1 illustrates an example architecture for a system **100** for capturing and analyzing user activity, in accordance with an embodiment.

In one embodiment, the system **100** comprises at least one client device **120**. As shown in FIG. **1**, the system **100** comprises multiple client devices **120**, such as Client **1**, Client **2**, Client **3**, Client **4**, . . . , and Client N, wherein N is an integer greater than 1. A client device **120** may be an electronic device such as an appliance, a personal computer (PC), a television (TV) such as a smart TV, or a mobile device (e.g., a mobile phone such as a smart phone, a laptop computer).

In one embodiment, each client device **120** can play back different types of content, including audio and video such as television programs, movies, and advertisements. Each client device **120** includes a display **122** (FIG. **2A**) for displaying content. A client device **120** may receive content for playback from one or more content distributors, such as a content provider (e.g., a television cable company), a content creator (e.g., a video podcaster), or an advertiser.

Each client device **120** further includes a camera component **131** (FIG. **2A**) for capturing/recording videos and/or images. In one embodiment, the camera module **131** is integrated with the client device **120**. In another embodiment, the camera module **131** is a separate client device **120**. As described in detail later herein, the system **100** uses the camera module **131** to capture user activity data, such as the facial expressions (e.g., laughter, crying) and the body

movements (e.g., jumping) of one or more users viewing content playing on the client device **120**.

In one embodiment, the system **100** further comprises a microphone module **132** (FIG. 2A) for capturing (e.g., recording) audio (i.e., sound) from the area surrounding the client device **120**. In one embodiment, the microphone module **132** is integrated with the client device **120**. In another embodiment, the microphone module **132** is a separate client device **120**.

As described in detail later herein, the system **100** uses the microphone module **132** to capture user activity data, such as the words spoken by one or more users viewing content playing on the client device **120**. The audio captured by the microphone module **132** may also be used to determine context data, such as the noise levels of the ambient environment (e.g., how noisy is the room where the client device **120** is situated).

Each client device **120** may establish a connection **110** to an external network, such as the Internet **50**. A connection **110** may be a wireless connection, a wired connection, or a combination of the two.

The system **100** further comprises a server unit **60** that is connected to the Internet **50** over a connection **110**.

A user operating a client device **120** may participate in a group video chat (i.e., video conference) while watching content playing on the client device **120**. The server unit **60** is configured to facilitate a group video chat between multiple client devices **120**. Each client device **120** participating in a group video chat sends a captured video stream and/or images to the server unit **60** via the Internet **50**, and simultaneously receives a video stream from the server unit **60** via the Internet **50**.

The server unit **60** receives an individual video stream from each client device **120** participating in a group video chat. For each participating client device **120**, the server unit **60** selects a subset of video streams from the video streams received, generates a combined video stream that includes the selected subset of video streams, and sends the combined video stream to the participating client device **120**. In one embodiment, each participating client device **120** receives the same combined video stream. In another embodiment, each participating client device **120** receives a different combined video stream.

FIG. 2A illustrates an example block diagram of a client device **120**, in accordance with an embodiment. The client device **120** further comprises a user interest measurement application module **200** for measuring user interest of content playing on the client device **120**, a memory unit **135** for storing data (e.g., locally captured video), a reaction capture application module **260** for recording and saving portions of the captured video stream indicating high user interest, and a video chat user interface application module **139** for generating a video chat user interface **125** for display on the display **122**.

FIG. 2B illustrates an example video chat user interface **125** displayed on a client device **120**, in accordance with an embodiment. The camera component **131** is configured to capture videos and/or images of one or more users **121** positioned in front of the camera component **131**.

In one embodiment, the camera component **131** captures a video stream (i.e., one continuous video) of one or more users during playback of content on the client device **120**. For example, as shown in FIG. 2B, the camera component **131** captures video and/or images of a user **121** watching a piece of content (e.g., a golf game) on the client device **120**. As described in detail later herein, the system **100** analyzes

the locally-captured video stream to determine the user's reaction to content playing on the client device **120**.

A user **121** may participate in a group video chat while simultaneously watching content on the client device **120**. As shown in FIG. 2B, the client device **120** is configured to simultaneously display content (e.g., the golf game) and a video chat user interface **125**. The placement of the video chat user interface **125** relative to the content playing on the client device **120** may vary. In one example, the video chat user interface **125** is positioned in the foreground of the display **122** while the content plays in the background. In another example, the video chat user interface **125** is positioned in the background of the display **122** while the content plays in the foreground. In yet another example, the display **122** displays the content in a first window **145** and the video chat user interface **125** next to the first window **145**, as shown in FIG. 2B.

The video chat user interface **125** displays a combined video stream received from the server unit **60**. As stated above, a combined video stream includes a selected subset of video streams. In one embodiment, the server unit **60** selects which participating client devices **120** to include in the combined video stream. In another embodiment, the client device **120** selects which participating client devices **120** that the server unit **160** should include in the combined video stream.

The video chat user interface **125** includes one or more video chat windows **140**. Each video chat window **140** displays a video stream captured by a different client device **120** participating in the group video chat. For example, as shown in FIG. 2B, the video chat user interface **125** displays a first video chat window **140A**, a second video chat window **140B**, and a third video chat window **140C**. The number of video chat windows **140** displayed may be based on one of the following: the user's group chat settings and the capabilities of the client device **120**. The number of client devices **120** participating in the group video chat may be more than the number of video chat windows **140** displayed on the display **122**.

In one embodiment, the server unit **60** selects which participating client devices **120** to include in the combined video stream based on measurements of user activity at each client device **120**. A measurement of user activity represents a degree of user interest in the content playing on a client device **120**. User interest may be calculated locally at the client device **120** or remotely at the server unit **60**.

FIG. 3 illustrates a block diagram of a user interest measurement application module **200**, in accordance with an embodiment. Measuring user interest at a client device **120** depends on multiple variables, such as the video motion of the locally captured video stream, the audio volume of the locally captured video stream, and the correlation between the audio and video ("A/V correlation") of the locally captured video stream. In one embodiment, the user interest of a client device **120** is calculated using relation (1) below:

$$I(v,a,t)=c_v*I_v(v,t)+c_a*I_a(a,t)+c_{av}*I_{av}(a,v,t) \qquad (1),$$

wherein $I(v, a, t)$ is the user interest of a client device **120**, $I_v(v, t)$ is the measured user interest based on video motion of the locally captured video stream, $I_a(a, t)$ is the measured user interest based on the audio of the locally captured video stream, $I_{av}(a, v, t)$ is the measured user interest based on the AV correlation of the locally captured video stream, c_v is the weight constant for $I_v(v, t)$, c_a is the weight constant for $I_a(a, t)$, and c_{av} is the weight constant for $I_{av}(a, v, t)$.

The system **100** further comprises a user interest measurement application module **200**. In one embodiment, the

user interest measurement application module **200** resides on the server unit **60**. In another embodiment, the user interest measurement application module **200** resides on a client device **120**. The user interest measurement application module **200** comprises a video unit **210** for determining $I_v(v, t)$, an audio unit **220** for determining $I_a(a, t)$, an AV correlation unit **230** for determining $I_{av}(a, v, t)$, and a storage device **240** for maintaining weight constants c_v, c_a and c_{av}, a user interest unit **250** for determining $I(a, v, t)$.

FIG. **4** illustrates motion detection processing of a video frame **290**, in accordance with an embodiment. The video unit **210** first processes each video frame **290** of a captured video stream using a motion detection algorithm, and generates a corresponding motion frame **300** for each video frame **290** processed. Each motion frame **300** highlights motion captured in a corresponding video frame **290**.

In one embodiment, the motion detection algorithm models the background of the captured video stream and subtracts the background modeled from each video frame to detect "motion" in the video frame. Each video frame **290** is converted to grayscale, and the background model m_0 is initialized to a first video frame f_0 of the captured video stream. At each subsequent video frame f_i of the captured video stream, the value of each background pixel b_{xy} is moved towards a corresponding value $f_{i,xy}$ of the frame f_i by 1 in accordance with relation (2) below:

$$b_{xy} = \begin{cases} b_{xy} + 1, & b_{xy} < f_{i,xy} \\ b_{xy} - 1, & b_{xy} > f_{i,xy} \\ b_{xy}, & b_{xy} = f_{i,xy}. \end{cases} \tag{2}$$

For each pixel $f_{i,xy}$ in the current frame f_i, the absolute difference between the value of a corresponding background pixel b_{xy} and the value of the pixel $f_{i,xy}$ is calculated using relation (3) below:

$$d_{xy} = |b_{xy} - f_{ixy}| \tag{3}$$

Let $m_{i,xy}$ represent the value of a pixel at coordinate (x, y) of an ith motion frame **300**. The value of each pixel $m_{i,xy}$ is set in accordance with relation (4) below:

$$m_{i,xy} = \begin{cases} 1, & d_{xy} \geq T \\ 0, & d_{xy} < T, \end{cases} \tag{4}$$

wherein T represents a preset threshold value. If d_{xy} is greater than or equal to the preset threshold value T, $m_{i,xy}$ is marked as a motion pixel (i.e., a moving pixel). If d_{xy} is less than or equal to the preset threshold value T, $m_{i,xy}$ is marked as a non-motion pixel. The preset threshold value T may be used to eliminate noisy pixels.

As shown in FIG. **4**, pixels of the motion frame **300** marked as motion pixels are represented in white, and pixels of the motion frame **300** marked as non-motion pixels are represented in black.

The video unit **210** then calculates metrics for each motion frame **300** generated. In one embodiment, the video unit **210** is configured to calculate the following metrics for an ith motion frame **300**: a normalized average x position $x_{avg,i}$, a normalized average y position $y_{avg,i}$, and a normalized motion level m_i. The normalized average x position $x_{avg,i}$ is calculated using relation (5) below:

$$x_{avg,i} = \sum_{x=0, y=0}^{x=w-1, y=h-1} \frac{x \times m_{i,xy}}{w} \bigg/ \sum_{x=0, y=0}^{x=w-1, y=h-1} m_{i,xy}, \tag{5}$$

wherein w represents the resolution width of the captured video stream, and wherein h represents the resolution height of the captured video stream.

The normalized average y position $y_{avg,i}$ is calculated using relation (60) below:

$$y_{avg,i} = \sum_{x=0, y=0}^{x=w-1, y=h-1} \frac{y \times m_{i,xy}}{h} \bigg/ \sum_{x=0, y=0}^{x=w-1, y=h-1} m_{i,xy}. \tag{60}$$

The normalized motion level m_i is calculated using relation (7) below:

$$m_i = \sum_{x=0, y=0}^{x=w-1, y=h-1} m_{i,xy} / w \times h. \tag{7}$$

FIG. **5** illustrates graphs corresponding to the metrics calculated by the video unit **210**, in accordance with an embodiment. The video unit **210** generates a graph over time (i.e., over video frame numbers) for each metric calculated. For example, as shown in FIG. **5**, the video unit **210** generates a first graph **351** for the normalized average x position $x_{avg,i}$, a second graph **352** for the normalized average y position $y_{avg,i}$, and a third graph **353** for the normalized motion level m_i. FIG. **5** further illustrates every 30th video frame **290** and the corresponding motion frame **300** for the captured video stream.

The video unit **210** is further configured to extract distinct graph patterns for distinct user actions from the graphs. For example, a graph pattern representing a user jumping up and down in front of the client device **120** may be different than a graph pattern representing a user who gets up and walks away from the client device **120**.

Over time, the graph patterns extracted may be used to train a pattern recognition algorithm that is used to classify portions of the captured video stream into different classes of user action. For example, a portion of a captured video stream showing a user jumping up and down in front of the client device **120** may be classified differently from a portion of the captured video stream showing a user who gets up and walks away from the client device **120**.

Interest weights may be assigned to different classes of user action. For example, the interest weight assigned to the user action of jumping up and down may be higher than the interest weight assigned to the user action of getting up and walking away. In one embodiment, $I_v(v, t)$ represents the sum of weighted user actions detected in the captured video stream.

FIG. **6** illustrates example audio spectrums, in accordance with an embodiment. In one embodiment, the audio unit **220** is configured to detect changes in volume or signal strengths over time in the audio of the captured video stream.

For example, FIG. **6** shows a first frequency spectrum **451** for a first piece of audio that includes occasional cheering and commenting from users, and a second frequency spectrum **452** for a second piece of audio including mostly background talking. The frequency of audio significantly

changes when an event indicating user interest, such as cheering or loud user comments, occurs. The differences between adjacent time slots of the frequency spectrum (e.g., 0.5 seconds) may be used as $I_a(a, t)$.

In another embodiment, the audio unit **220** is configured to detect Mel-frequency cepstral coefficients (MFCCs) for the audio of the captured video stream. FIG. **6** further shows a first representation **461** of MFCC values corresponding to the first frequency spectrum **451**, and a second representation **462** of MFCC values corresponding to the second frequency spectrum **452**. MFCC values are higher when an event indicating user interest, such as cheering or loud user comments, occurs. Normalized MFCC values may be used as $I_a(a, t)$.

The A/V correlation unit **230** is configured to receive $I_v(v, t)$ and $I_a(a, t)$ from the video unit **210** and the audio unit **220**, respectively. In one embodiment, the A/V correlation unit **230** calculates $I_{av}(a, v, t)$ using relation (8) below:

$$I_{av}(a, v, t) = \begin{cases} 1, & \text{if } I_v(v, t) > \alpha \text{ and } I_a(a, t) > \beta \\ 0, & \text{otherwise,} \end{cases} \quad (8)$$

where α and β are thresholds for $I_v(v, t)$ and $I_a(a, t)$, respectively.

In another embodiment, the A/V correlation unit **230** may account for a phase difference between audio and video. In this specification, let T_p and T_f represent a look behind and a look ahead period, respectively. Let $I_{v,max}(v, t)$ represent the maximum value of $I_v(v, t)$ over the range $[t-T_p, t+T_f]$ and let $I_{a,max}(a, t)$ represented the maximum value of $I_a(a, t)$ over the $[t-T_p, t+T_f]$ range. The A/V correlation unit **230** calculates $I_{av}(a, v, t)$ using relation (9) below:

$$I_{av}(a, v, t) = \begin{cases} 1, & \text{if } I_v(v, t) > \alpha \text{ and } I_{a,max}(a, t) > \beta \\ 1, & \text{if } I_{v,max}(v, t) > \alpha \text{ and } I_a(a, t) > \beta \\ 0, & \text{otherwise.} \end{cases} \quad (9)$$

FIG. **7** is a timeline **280** illustrating the capture of a user reaction, in accordance with an embodiment. The reaction capture application module **260** is configured to record an ongoing user reaction using in-memory buffering.

Specifically, to classify portions of the captured video stream into different classes of user action, the video unit **210** references a previous set of video frames **290**. As such, the earliest the user interest measurement application module **200** can determine $I(v, a, t)$ is at time $t+T_p$, wherein T_p represents the duration of a detected user action.

To eliminate or minimize video delay, the reaction capture application module **260** maintains a video buffer in the memory unit **135**, wherein the duration of video maintained in the video buffer T_b is greater than T_p. The video buffer maintained potentially includes a portion of the captured video stream that shows a user reaction. After the start and end time of a user reaction is determined, the reaction capture application module **260** cleans up the video buffer, and continues to save another portion of the ongoing video stream.

For example, as shown in FIG. **7**, a user is active between time T_1 and time T_2 of the timeline **280**. User interest $I(v, a, t)$ of a piece of content playing on the client device **120** varies over time. At time $T_3=T_1+T_p$, the user interest $I(v, a, T_1)$ is calculated and a user reaction is detected. The reaction capture application module **260** maintains video from time

T_3-T_b onwards, and begins recording the rest of the captured video stream. At time T_2 the user is no longer active. At time $T_4=T_2+T_p$, the user interest $I(v, a, T_2)$ is calculated at. Duration T_c represents the ending portion of a user reaction. The reaction capture application module **260** records the video from time T_3-T_b to time T_4+T_c, thereby ensuring that the entire user reaction is captured. The video of the user reaction may be sent to the server unit **60** or posted to a social networking site.

In one embodiment, user reactions may be pre-recorded and used as an extra indicator to detect a user reaction. By maintaining videos of different user reactions (cheering, laughing, bouncing, hand clapping, etc.), the system **100** can calculate the user interest value for the videos and use the videos as templates.

In one embodiment, the system **100** may utilize inputs from external resources. For example, when a soccer game is playing on a client device **120**, the start time of user reaction is usually close to a scoring event in the soccer game. The system **100** can obtain information relating to scores of the soccer game, and determine increased user interest when the score changes. Other resources may be used, such as resources relating to crowd sourcing (e.g., comments posted to Twitter® during the soccer game), and commentary from sports broadcasters, etc.

When there are multiple clients in the system **100**, the server unit **60** can collect the values of user interest from different client devices **120** over time. If a large percentage of client devices **120** start to provide high user interest values, the system **100** may determine that an event of interest is occurring and send recording command to all the client devices **120**.

FIG. **8** illustrates a block diagram of a server unit **60**, in accordance with an embodiment. In one embodiment, the server unit **60** comprises a video selection application module **265**. The video selection application module **265** receives a video stream from each client device **120** participating in a group video chat. The video selection application module **265** selects a subset of participants based on the measurements of user interest determined by the user interest measurement application module **200**, and composes a combined video stream including the video streams of the selected subset of participants.

In one embodiment, the video selection application module **265** also receives from each participating client device **120** a metric representing user interest $I(a, v, t)$. In another embodiment, the server unit **60** further comprises a user interest measurement application module **200** for calculating user interest $I(a, v, t)$ for each participating client device **120**. The video selection application module **265** may select the most active participants based on the user interest metrics received.

In one embodiment, the combined video stream is sent to all participating client devices **120**. In another embodiment, the video selection application module **265** sends a different combined video stream to a participating client device **120** on the preferences of the client participating device **120**. For example, the video selection application module **265** may also receive from each participating client device **120** a list of preferred users that the participating client device **120** wants to video chat with. The video selection application module **265** may select which participants to include in the combined video stream based on the user interest metrics and the list of preferred users received.

In one embodiment, to conserve networking resources, each participating client device **120** first sends the calculated user interest metric to the server unit **60**. The server unit **60**

then requests a video stream from a participating client device **120** only if the participating client device **120** is selected.

A client device **120** can set user preferences indicating which participating clients should be included in the video chat windows available, thereby leaving the remaining chat windows, if any, to other participating clients with the highest user interest values.

In one embodiment, the system **100** allows for each participating client device **120** to vote for which participant to include in the combined video stream.

In one embodiment, the server unit **60** re-selects participants after a particular duration of time has elapsed (e.g., 10 seconds).

FIG. **9** illustrates an example flow chart **600** for selecting video streams to include in a combined video stream, in accordance with an embodiment. In process block **601**, the process starts. In process block **602**, a list of preferred clients is received from each of the N participating clients. In process block **603**, a video stream of the client is received from each participating client. In process block **604**, a metric representing the client's user interest in the content playing on the client's client device is calculated or received from each participating client. In process block **605**, M clients with the highest values for user interest is selected. In process block **606**, for a participating client, whether any of the client's preferred clients is a participating client is determined. If any of the preferred clients is a participating client, then proceed to process block **607** to generate a combined video stream for the participating client that includes K preferred clients and the top M-K clients with the highest values of user interest. If not, proceed to process block **608** to generate a combined video stream for the participating client that includes the top M clients with the highest values of user interest. In process block **609**, the combined video stream is sent to the participating client. In process block **610**, whether there are any remaining participating clients that have not yet received a combined video stream is determined. If there are remaining participating clients, then return to process block **606**. If not, proceed to process block **611** where the process ends.

FIG. **10** is a high-level block diagram showing an information processing system comprising a computing system **500** implementing an embodiment. The system **500** includes one or more processors **511** (e.g., ASIC, CPU, etc.), and can further include an electronic display device **512** (for displaying graphics, text, and other data), a main memory **513** (e.g., random access memory (RAM)), storage device **514** (e.g., hard disk drive), removable storage device **515** (e.g., removable storage drive, removable memory module, a magnetic tape drive, optical disk drive, computer-readable medium having stored therein computer software and/or data), user interface device **516** (e.g., keyboard, touch screen, keypad, pointing device), and a communication interface **517** (e.g., modem, wireless transceiver (such as WiFi, Cellular), a network interface (such as an Ethernet card), a communications port, or a PCMCIA slot and card). The communication interface **517** allows software and data to be transferred between the computer system and external devices and/or networks, such as the Internet **550**, a mobile electronic device **551**, a server **552**, and a network **553**. The system **500** further includes a communications infrastructure **518** (e.g., a communications bus, cross-over bar, or network) to which the aforementioned devices/modules **511** through **517** are connected.

The information transferred via communications interface **517** may be in the form of signals such as electronic, electromagnetic, optical, or other signals capable of being received by communications interface **517**, via a communication link that carries signals and may be implemented using wire or cable, fiber optics, a phone line, a cellular phone link, an radio frequency (RF) link, and/or other communication channels.

The system **500** further includes an image capture device **520** such as a camera **131** and an audio capture device **519** such as a microphone **132**. The system **500** may further include application modules as MMS module **521**, SMS module **522**, email module **523**, social network interface (SNI) module **524**, audio/video (AV) player **525**, web browser **526**, image capture module **527**, etc.

The system **500** further includes a user engagement module **530** for measuring user engagement of content as described herein, according to an embodiment. In one embodiment, the user engagement module **530** along with an operating system **529** may be implemented as executable code residing in a memory of the system **500**. In another embodiment, the user engagement module **530** along with the operating system **529** may be implemented in firmware.

As is known to those skilled in the art, the aforementioned example architectures described above, according to said architectures, can be implemented in many ways, such as program instructions for execution by a processor, as software modules, microcode, as computer program product on computer readable media, as analog/logic circuits, as application specific integrated circuits, as firmware, as consumer electronic devices, AV devices, wireless/wired transmitters, wireless/wired receivers, networks, multi-media devices, etc. Further, embodiments of said architecture can take the form of an entirely hardware embodiment, an entirely software embodiment or an embodiment containing both hardware and software elements.

Embodiments have been described with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems) and computer program products according to embodiments. Each block of such illustrations/diagrams, or combinations thereof, can be implemented by computer program instructions. The computer program instructions when provided to a processor produce a machine, such that the instructions, which execute via the processor create means for implementing the functions/operations specified in the flowchart and/or block diagram. Each block in the flowchart/block diagrams may represent a hardware and/or software module or logic, implementing embodiments. In alternative implementations, the functions noted in the blocks may occur out of the order noted in the figures, concurrently, etc.

The terms "computer program medium," "computer usable medium," "computer readable medium", and "computer program product," are used to generally refer to media such as main memory, secondary memory, removable storage drive, a hard disk installed in hard disk drive. These computer program products are means for providing software to the computer system. The computer readable medium allows the computer system to read data, instructions, messages or message packets, and other computer readable information from the computer readable medium. The computer readable medium, for example, may include non-volatile memory, such as a floppy disk, ROM, flash memory, disk drive memory, a CD-ROM, and other permanent storage. It is useful, for example, for transporting information, such as data and computer instructions, between computer systems. Computer program instructions may be stored in a computer readable medium that can direct a computer, other programmable data processing apparatus,

or other devices to function in a particular manner, such that the instructions stored in the computer readable medium produce an article of manufacture including instructions which implement the function/act specified in the flowchart and/or block diagram block or blocks.

Computer program instructions representing the block diagram and/or flowcharts herein may be loaded onto a computer, programmable data processing apparatus, or processing devices to cause a series of operations performed thereon to produce a computer implemented process. Computer programs (i.e., computer control logic) are stored in main memory and/or secondary memory. Computer programs may also be received via a communications interface. Such computer programs, when executed, enable the computer system to perform the features of one or more embodiments as discussed herein. In particular, the computer programs, when executed, enable the processor and/or multicore processor to perform the features of the computer system. Such computer programs represent controllers of the computer system. A computer program product comprises a tangible storage medium readable by a computer system and storing instructions for execution by the computer system for performing a method of one or more embodiments.

Though one or more embodiments has been described with reference to certain versions thereof; however, other versions are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred versions contained herein.

What is claimed is:

1. A system for facilitating a video chat session between multiple client devices, the system comprising:

at least one processor; and

a non-transitory processor-readable memory device storing instructions that when executed by the at least one processor causes the at least one processor to perform operations including:

receiving information units from the multiple client devices, wherein each information unit represents activity, at a client device of the multiple client devices, at least partially overlapping in duration with playback of a piece of content on the client device;

selecting a subset of information units from the information units received based on measurements of activity in the information units received; and

generating a combined video stream including the selected subset of information units, wherein the combined video stream is sent to at least one client device of the multiple client devices for display at least partially overlapping in duration with the piece of content on the at least one client device.

2. The system of claim 1, wherein:

each measurement of activity represents a degree of interest at a client device of the multiple client devices; and

each information unit received from each client device comprises a video stream capturing activity at the client device.

3. The system of claim 2, wherein the operations further include:

receiving, from each client device, preferences for the client device, selecting at least one information unit from the information units received based on the preferences for the client device, and generating a combined video stream including the at least one information unit selected for the client device.

4. The system of claim 2, wherein the operations further include:

for each video stream received, determining a measurement of activity captured in the video stream.

5. The system of claim 2, wherein the operations further include:

receiving, from each client device, a measurement of activity captured at the client device.

6. The system of claim 2, wherein:

the selected subset of information units include a video stream with highest measurement of activity among the information units received.

7. The system of claim 1, wherein:

each information unit further represents user activity captured at a client device of the multiple client devices during playback of a piece of content on the client device; and

the combined video stream is sent to at least one client device of the multiple client devices for simultaneous display with the piece of content on the at least one client device.

8. A method for facilitating a video chat session between multiple client devices, the method comprising:

receiving information units from the multiple client devices, wherein each information unit represents activity, at a client device of the multiple client devices, at least partially overlapping in duration with playback of a piece of content on the client device;

selecting a subset of information units from the information units received based on measurements of activity in the information units received; and

generating a combined video stream including the selected subset of information units, wherein the combined video stream is sent to at least one client device of the multiple client devices for display at least partially overlapping in duration with the piece of content on the at least one client device.

9. The method of claim 8, wherein:

each measurement of activity represents a degree of interest at a client device of the multiple client devices that is determined based on activity at the client device;

each information unit received from each client device comprises a video stream capturing activity at the client device; and

the selected subset of information units include a video stream with highest measurement of activity among the information units received.

10. The method of claim 9, further comprising:

sending the combined video stream to each client device.

11. The method of claim 9, further comprising:

for each client device:

receiving preferences for the client device;

selecting at least one information unit from the information units received based on the preferences for the client device; and

generating a combined video stream including the at least one information unit selected for the client device.

12. The method of claim 9, further comprising:

for each video stream received, determining a measurement of activity captured in the video stream.

13. The method of claim 9, further comprising:

receiving, from each client device, a measurement of activity captured at the client device.

14. A non-transitory computer-readable medium storing instructions that, when executed by at least one processor of a machine, cause the machine to perform operations comprising:

receiving information units from the multiple client devices, wherein each information unit represents activity, at a client device of the multiple client devices, at least partially overlapping in duration with playback of a piece of content on the client device;

selecting a subset of information units from the information units received based on measurements of activity in the information units received; and

generating a combined video stream including the selected subset of information units, wherein the combined video stream is sent to at least one client device of the multiple client devices for display at least partially overlapping in duration with the piece of content on the at least one client device.

15. The non-transitory computer-readable medium of claim 14, wherein:

each measurement of activity represents a degree of interest at a client device of the multiple client devices that is determined based on activity at the client device;

each information unit received from each client device comprises a video stream capturing activity at the client device; and

the selected subset of information units include a video stream with highest measurement of activity among the information units received.

16. The non-transitory computer-readable of claim 15, the method further comprising:

for each client device:

receiving preferences for the client device;

selecting at least one information unit from the information units received based on the preferences for the client device; and

generating a combined video stream including the at least one information unit selected for the client device.

17. The non-transitory computer-readable medium of claim 15, the method further comprising:

for each video stream received, determining a measurement of activity captured in the video stream.

18. The non-transitory computer-readable medium of claim 15, the method further comprising:

receiving, from each client device, a measurement of activity captured at the client device.

19. An electronic device for facilitating a video chat session, comprising:

a display;

a camera;

at least one processor; and

a non-transitory processor-readable memory device storing instructions that when executed by the at least one processor causes the at least one processor to perform operations including:

capturing a video stream of activity at the electronic device during playback of a piece of content on the display;

receiving a combined video stream including at least one video stream of activity captured at a different electronic device;

generating a graphical user interface (GUI) comprising at least one video chat window, wherein each video chat window corresponds to a video stream included in the combined video stream, and the chat window includes a video stream of activity captured at a different electronic device; and

simultaneously displaying the piece of content and the GUI generated on the display.

20. The electronic device of claim 19, wherein:

the electronic device receives the combined video stream from a server; and

the electronic device sends the video stream of activity captured at the electronic device to the server.

21. The electronic device of claim 20, wherein the operations further include:

measuring interest in the piece of content based on a measurement of activity captured at the electronic device, wherein the electronic device sends data relating to the measured interest to the server.

22. The electronic device of claim 20, wherein the operations further include:

detecting and recording a reaction at the electronic device during the playback of the piece of content on the display.

23. The electronic device of claim 22, wherein:

the recorded reaction is sent to at least one of the server and a social networking site.

24. The electronic device of claim 20, wherein:

the electronic device sends preferences to the server; and

the combined video stream received from the server is based in part on the preferences.

25. A graphical user interface (GUI) displayed on a display device, comprising:

a first window for displaying a piece of content; and

a video chat interface for facilitating a video chat session with one or more other devices during playback of the piece of content, the video chat interface comprising at least one video chat window, each video chat window corresponding to a video stream included in a combined video stream received at the display device, and each chat window including a video stream of activity, at an other device of the one or more other devices, at least partially overlapping in duration with playback of the piece of content on the other device;

wherein the GUI simultaneously displays the piece of content and the video chat interface on the display device.

26. The GUI of claim 25, wherein:

the number of video chat windows included in the video chat interface is based on preferences.

27. The GUI of claim 25, wherein:

the number of video chat windows included in the video chat interface is based on capabilities of the display device.

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